Usability Inspection of a GPS Navigation System

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ABSTRACT

GPS Navigation Systems are starting to become optional factory installed components in higher-end vehicles. One of the most important aspects of these systems is their usability. Most users of these systems will not be reading the user manual; they will be learning the system by exploring the system and by trial and error. This paper explores a Pocket PC based GPS Navigation system's usability by using a Cognitive Walkthrough to determine how certain characteristics in the user interface may help and hinder the user in learning by exploration.

Keywords

GPS Navigation, Cognitive Walkthrough.

1. INTRODUCTION

Global Positioning Satellite (GPS) Navigation Systems are starting to become optional factory installed components in higher-end vehicles. This adding of new technology to luxury vehicles is similar to what happened when CD players were first introduced in luxury vehicles: eventually this technology will become less expensive and will find its way into middle to lower end cars just as CD players have found their way.

GPS Navigation Systems in cars offer much more than an active map with routing capabilities. Most systems can tell users their estimated time of arrival and miles until destination. Most systems also have a "Points of Interest" database where users can look up destinations such as restaurants, golf courses, shopping centers, and parking. In addition, users can choose to avoid toll roads, route using the estimated quickest route or take the absolute shortest route.

Currently there are many software / hardware systems that offer GPS navigation functionality in automobiles and there will probably continue to be many different solutions into the future. There are in-dashboard systems, and there are systems that can easily be moved from car to car. There are many different hardware platforms that GPS Navigation Systems have been built on. There are custom / proprietary platforms such as Garmin, Alpine, Kenwood, and Pioneer which cost between $800-$2500. There are also systems based on generic computing platforms such as Palm OS, Pocket PC, and Windows. The cost of entry into the generic computing platforms is basically the cost of the software and the cost of a GPS receiver which can be had for under $200[2] if the user already owns a compatible system.

Currently a constraint that is preventing the generic computing solutions from gaining market share is that most people with notebook computers don't want to use them in the car all of the time and that most people don't carry PDA devices. In the future, this is likely to change. PDA phones are becoming cheaper and more widespread. Manufacturers are exploring adding hard drives to phones. Eventually PDA phones could be as common as picture phones and everyone will have easy access to a computer / display that would be capable of running a GPS Navigation System.

When CD players were first introduced to automobiles, there was little that new users had to learn. Many people already had experience with CD players in their homes. The interface was not different. For users who were familiar with using cassette tapes, the interface was very similar and easy to use.

GPS Navigation System users on the other hand may or may not have experience with computers. They may or may not have used a GPS Navigation System in the past. Most likely they are used to using paper maps. Others may have experience using a non-interactive Internet mapping service such as Microsoft Mappoint or Mapquest.

Many new users may find themselves in a situation where they have the hardware/software solution in front of them for the first time and they want to use it. This situation could occur if the person is renting a car with a system, if someone is test driving a car or even just borrowing a friend or family member's car. In this situation it would be very important for the user to be able to learn how to use the software by exploration since the manual is not immediately available.

Being able to learn by exploration is a very important usability aspect for GPS Navigation Systems. The user may weigh the benefits of using the system versus the time spent in reading a manual in deciding whether or not to take time to read the manual. If the user is new to using a GPS Navigation System, he may discount the true power of using the GPS Navigation System and delaying using it. This delay could cause him to be late for appointments, get lost, or even create a safety risk if he is forced to use paper maps. Also advocating the ease of learning by exploration in a GPS Navigation System is that there might not be a manual available, or it may be written / translated poorly. If this is the case, learning by exploration is paramount in the usability of the system.

One method for evaluating an interface for ease of learning my exploration is Cognitive Walkthrough. The Cognitive Walkthrough method attempts to identify usability defects such as poor wording in interface elements and inadequate feedback in response to certain actions [5]. By identifying usability defects that might lead to interfering with the learning of the interface by exploration, this method aids in making recommendations that could possibly enhance the evaluated interface and/or future interfaces.

2. OTHER WORK

In 2002 a study was done that performed a Cognitive Walkthrough of a GPS Navigation system. The study evaluated the Toyota Navigation System that was an option in some of their 2001/2002 models. The study concentrated on three aspects of the system. The first was the actual task of navigating after a destination was entered into the system. The second involved setting the destination into the system. The third consisted of switching the radio to navigation system [1]. Of these three tasks, the first and second are general GPS navigation tasks that would be present in any system. The third task is a specific task that

would apply to systems that are a component of the car's audio system.

Other work has been done to identify usability defects in GPS Navigation Systems using other inspection methods [6, 7]. One study studied four different navigation systems using a combination of Heuristic Evaluation and Formal User Testing. The study consisted of investigating for usability defects in the tasks of entering a destination into the system and with the actual route-guidance aspect of the system. Many suggestions were made that would improve the usability of the interface [6]. These considerations were made without out considering their impact on the "Walk-up-and-Use" qualities of the interface that a Cognitive Walkthrough would analyse [4].

3. COGNITIVE WALKTHROUGH

The Cognitive Walkthrough process attempts to uncover usability defects that might hinder the users' ability to learn an interface by exploration. The process involves defining the inputs to the walkthrough, performing the walkthrough, and reporting the results. If the walkthrough is performed as part of the development process, defects can be corrected and the process can be iterated over many times to minimize the detection of usability defects [5].

The first step of a Cognitive Walkthrough is to identify the inputs. First, the users of the software and their experience must be defined. Do the users have any computer experience at all? Are the likely to be afraid of making a decision within the interface? Are they familiar with the Windows XP interface? Have they ever used a PDA? Next, the tasks for the walkthrough must be defined. For each task, a sequence of actions must be defined that will complete the task. Finally, the actual interface that is to be inspected must be defined. This interface can be a mock up or the actual product [5].

After the inputs have been defined the actual inspection process can begin. The inspection process can be conducted by an individual analyst or a group of analysts. This process involves stepping through each of the actions that the task defines and making observations of how the user who is inexperienced with the interface might react to that action in the task. These observations must be based on the knowledge and experience of the user class that is being examined. These observations should be able to tell a believable story about how the user would interact with the interface. Does the user have to remember anything from the previous step? Will the user choose the correct option? Will time delays due to user confusion affect the results of the task? Could the wording confuse the user? Will the user know when he is at the next step of the task? All of these results are then recorded. The knowledge gained from these questions can be used to improve the evaluation interface and/or can be used to improve other and new interfaces.

4. IGUIDANCE 2.0 WALKTHROUGH

iGuidance 2.0 was evaluated using the Cognitive Walkthrough method. The software runs on the both Microsoft Windows and on Pocket PC. This study analyses only the Pocket PC version of the product. This software implements almost every GPS Navigation feature available on its more expensive counter parts except the feature that allows the system to speak out the actual name of every street it may come across. This was probably not included because PDA devices usually have limited storage capacity. iGuidance 2.0 can be purchase for little over $109 over the Internet [2].

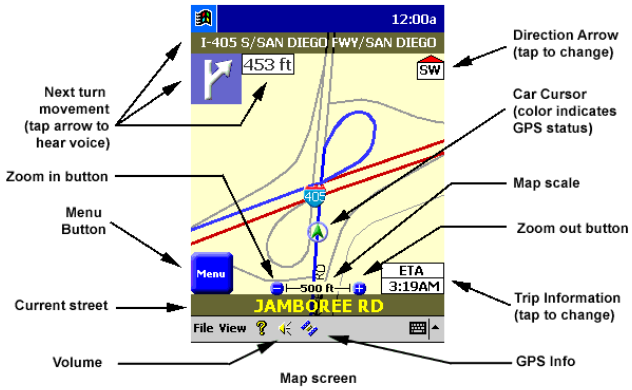

Figure 1. Map Screen.

The first display is the map screen (See figure 1). The map screen is the interface that the user sees when not engaged in making a turn or engaged in setting navigation settings using the menus. The current street and the next street are located at the bottom and top of the displays respectively. There is a menu bar at the bottom of the screen that allows users to access the same functionality that the menu button allows them to access. In the upper left hand corner, there is information on what direction and how far the next turn will be. In the upper right, there is a compass that changes based on what direction the GPS receiver senses the movement of the car to be. The lower right corner provides three pieces of information that can be retrieved by single clicking on the value to go to the next. These values are the current speed of the vehicle, the estimated time of arrival and the estimated time left in the trip. In the lower right of the screen, there is blue button which is labelled menu that activates the main menu screen of the system which is used mainly to enter destinations into the navigation system. In the middle of the display, on the bottom, the zoom scale level is displayed between a negative and a positive sign. The negative and the positive sign are used to decrease and increase the zoom level of the map.

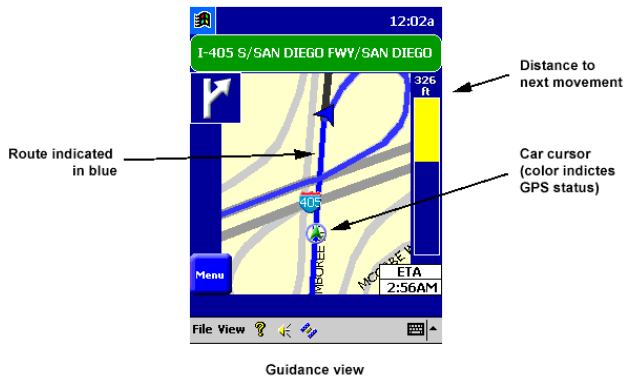

Figure 2. Guidance View.

The next screen is the guidance view (See figure 2). This screen comes up when the user is about 10 seconds from the next turn. The display is automatically zoomed to a level where the turn is easily understood. In addition to the controls inherited by this screen from the map screen, the right hand side of the screen offers a count down bar which decreases down to zero as the critical turn of the navigation approaches.

The main menu screen (See figure 3) allows access to most of the normal day to functions that are required as part of a GPS Navigation System. The most used functionality of any navigation system is the ability to enter in a destination. The Destinations button activates a screen which gives the user seven ways to select a destination (See figure 4). The user can easily choose a specific address, the intersection of two cross roads, or the center of a city. The user can also select a destination based on previously entered destinations by using the favorites, recent, and contacts menu options. In addition to the address centric destination options there is an extensive points-of-interest database of destinations.

Figure 3. Main Menu.

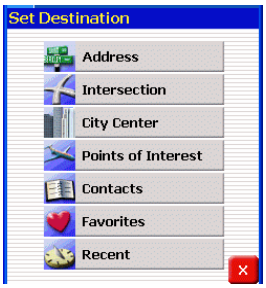

Figure 4. Destination Menu.

The points-of-interest menu is very extensive (See figure 5). It is a multi-level menu that allows users to drill down to a specific destination they are looking for. For example, after choosing Attraction, the use can then select a more specific category such as Museum (See figure 6). After the details of the point of interest are selected by the user, the user can then select to view the points of interest that are within 25 miles of the current map location or then can choose to see points of interest that are near a specific city (See figure 8).

Figure 5. Points of Interest Menu.

Figure 6. Destination Drill Down Menu.

The route options menu allows the user to configure routing options. Here the user can choose to take the shortest route, the quickest route, the route with primarily major roads, or only local roads. In addition, the user can set routing parameters that will reduce turns, include toll roads and include carpool lanes (See figure 7).

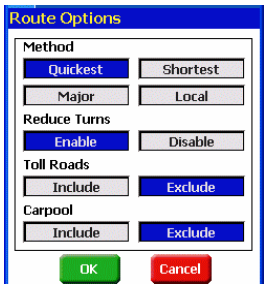

Figure 7. Route Options Menu.

There are a few other options from the main menu that are not used very often, but that are easily accessible. The display options menu allows the user to configure the map display options. The user can choose to have the map automatically rotate with the movement of the car or to the north always pointing up. The user can also choose between a night and day color scheme or have it automatically change. Other options on this menu include being able to turn points of interest icons on and off and various 3D map view options.

The speed alert menu option allows the user to set speed thresholds that will activate a beeping noise when the threshold is exceeded. The record menu option allows the user to record their

route for later playback. The volume menu option allows the user to set and test the volume of the voice navigation signals independently of the computer's volume. The GPS info menu option allows the user to see the detailed information that the GPS receiver is sending to the computer. This is useful in troubleshooting.

In addition to the graphical display, there is also a voice navigation aspect to the system. The voice navigation system can be enable or disabled. It is limited to simple navigation instructions such as "Turn right", "Drive 3.6 miles", and "Bear right onto interstate 90" because it is comprised of a collection of wav files that are concatenated together to make the instructions. The instructions to turn are given a couple minutes before the turn and then again about 10 seconds before the turn must be made.

For this Cognitive Walkthrough two classes of users were defined. The first class is computer savvy users who have experience with Microsoft Windows, Palm and Pocket PC type interfaces. They are familiar with all of the input methods on a Pocket PC and they have been using a Pocket PC for at least six months. This class is also not afraid to try things, understands that most actions on a computer are reversible, and is not afraid to reboot and start over. The second class of users is your common office worker who has a working knowledge of Windows and Microsoft Office. They are comfortable with a mouse, comfortable with files and folders, and comfortable calling the first class of users for help when they have a problem (Or even think they have a problem).

Figure 8. Points of Interest Options.

For each user class, a Cognitive Walkthrough was performed by a single analyst. The task that was analyzed involved setting up the system to route to the closest shopping mall using by taking the absolute shortest route. A user may be motivated to take the shortest path for any number of reasons. They may wish to limit the mileage on their car or they may like to explore an unfamiliar area by taking a different route to a destination. The action sequence associate with this task is listed in Table 1.

5. RESULTS

The map screen does not offer button that says enter destination but does offer a blue button that says menu (See figure 1). Both classes of users would not have a problem with this step for a few reasons. First, the button is blue which offers good contrast between both the night dark background and the day time yellow background. Secondly, the Menu button appears to be 3D so users will be more inclined to press it. Lastly, most people associate the word menu with a list of choices. This makes the Menu button is a good choice when the next move is not explicit.

Table 1. Action Sequence for Navigating to the closet shopping mall from a parking lot by taking the shortest route

Seq #	Task	Seq #	Task
1.	Select Menu	8.	Select Nav
2.	Select Destination	9.	Select Menu
3.	Select Points of Interest	10.	Select Route Opts
4.	Select Business/Shopping	11.	Select Shortest
5.	Select Shopping	12.	Select OK
6.	Select By Distance	13.	Select Map View
7.	Select Closest Mall		

Figure 9. Points of Interest List.

The next step involves selecting the destination option on the main menu. This step could create confusion for the user. There are two options the user might consider based. The first and correct option is the destination option. Both classes of users would consider pressing this button because their immediate goal is to enter a destination to navigate or route to. The next option that the user might consider is the route opts option. The computer savvy user is most likely to realize this option for what it is, options on the routing algorithm. The non-computer savvy user may not realize that multiple routing algorithms even exist, so he may be tempted to press this button because the immediate goal revolves around the idea of routing to a destination. If pressed, the non-computer savvy person will immediate realize that they made a mistake. The route options menu has a clearly marked cancel button which returns the user to the previous display so all is not lost (See figure 7). The non-computer savvy user will then press the destinations button and continue to the next step in the action sequence.

The next step in the action sequence is to select the points of interest option on the destinations menu (See figure 4). This could confuse both classes of users because they may be tempted to guess an exact address for the closest shopping mall if they know what street it is on. The icon next to the points-of -interest option is an airplane which has nothing to do with a shopping

mall. An improvement to this interface might be to remove icons from this screen. The icons are pretty, but they add little to the usability. All of the points of interest categories could easily accessible through a drop down box on the same menu. Most computer users are familiar with the idea of a drop down box and would easily be able to explore them if they were on destinations menu.

After the points of interest option is selected, the user then needs to select Business/Shopping (See figure 5) and then Shopping. These options are straight forward and obvious to both classes of users.

The next menu might confuse the both classes of users (See figure 9). The title of the screen is "Points of Interest Options". The purpose of this screen is to allow the user to specify a specific geographical area to search for points of interest. A better choice might have been to title the screen as "POI Geographical List Opts". Both classes of users would not be confused by the abbreviation of points of interest since they both know they selected that option a few steps before. The additional description of "Geographic List Opts" would make more sense to what sub-task was to be accomplished on this menu. Another feature that may confuse users is the change button. It is not clear what this button actually changes. Its intended use is to change the current state the "List All" button generates its list from. This screen has ample space to correct this confusion. The list all button's label could be changed to "List all in California" and the change button's label could be changed to "Change State". Alternatively, a simple drop down box allowing the user to change the state right on the menu would have been sufficient in this situation. For simplicity, we will assume that the closest shopping mall is within 25 miles. Both classes of users will easily be able to determine that the next step is to select "By Distance".

The next display is the list of possible points of interest (See figure 9). Both users would easily be able to scroll through the list of destination and be able to select the closest mall. After selecting the destination, both classes of users may be confused on whether or not to select Map or the Nav button. The correct selection is the Nav button, but the user may see Map and think of it as the action of mapping a route. This display could be improved by allocating more space to describe the buttons on the bottom of the screen. This can be accomplished by removing the two yellow scroll buttons on the lower left side of the display. These are unneeded since there is an adequate scroll bar on the right side of the display.

After Nav is selected from the POI List display, the map screen (See figure 1) is displayed again, in routing mode. The routing mode uses the routing algorithm that is selected on the routing options menu. The map screen does not display what algorithm is being used. If the user wishes to change or verify that the routing algorithm selected is the shortest method, the user must go through the correct sequence of actions. The first action is to select the menu button to go back to the main menu. At the Main Menu, both classes of users will choose the route opts option. This is the only reasonable selection. If they had accidentally chosen this option when they were suppose to select destination, they may remember the resulting route opts menu (See figure 7) which had the desired options for this part of the task.

On the route options menu the choice to choose the Shortest method for routing is obvious to both classes of users. Next the user needs to select OK and then select the Map View. These steps are very simple and there are no obvious distractions that may confuse the user.

6. CONCLUSIONS

Almost the all of the screens, except the main menu screen, presented the user with an "out" to go back to the previous screen. This allows the user to backtrack until the point where they got confused. This was a major strength in this application that allowed the application to be very easily learned by exploration.

As computing speed, available memory, mobile networking and screen resolution continue to grow in PDAs and in proprietary GPS Navigation Systems, so will the features that are available. Future systems will likely implement intelligent routing that dynamically changes how routes are calculated based on traffic data. Higher screen resolutions will allow more detailed maps and more detailed interface components. More processing power will allow for voice recognition systems that can be totally controlled by the users' voice. These possible new features will open up many opportunities for more work in the area of GPS Navigation System Cognitive Walkthroughs.

7. REFERENCES

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